THE STARFISH EXO-ATMOSPHERIC, HIGH ALTITUDE NUCLEAR WEAPONS TEST

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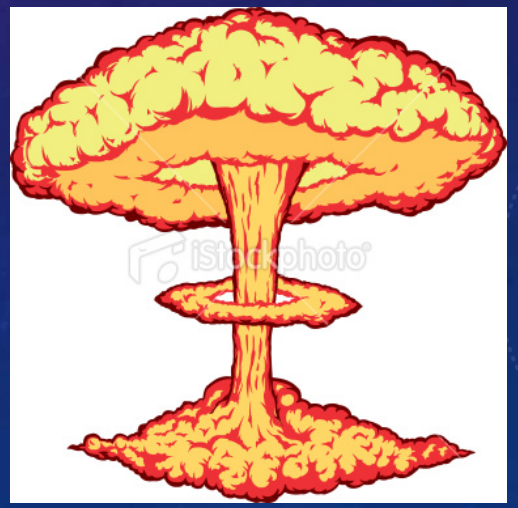
ACRONYMS

- ARGUS = Analytical Reports Gathering & Updating System
- FISHBOWL = Operation Fishbowl was a series of high altitude nuclear tests in 1962
- HARDTACK = Operation HARDTACK was a nuclear testing series conducted in Nevada
- Starfish Prime = nuclear test in space in 1962

STARFISH

- Atmospheric tests
- Purpose: To study the effects of nuclear weapons
  - 1958
    - HARDTACK—Pacific Ocean
    - ARGUS—South Atlantic Ocean
  - 1962
    - FISHBOWL series



STARFISH

- FISHBOWL series
  - STARFISH PRIME device
    - July 9, 1962
    - 1.4 Megatons TNT equivalent
    - 400 km over Johnston Island
      - (Pacific Ocean, 700 km southwest of Hawaii.)

STARFISH

- STARFISH PRIME device
  - Exo-atmospheric nuclear explosion
  - Released about 10^{29} energetic fission electrons into the magnetosphere
  - Created an artificial radiation belt
  - Raised the intensity levels of the Van Allen Belt electron population in the inner zone

STARFISH

- TELSTAR
  - Launched one day after STARFISH.
  - Experienced a total dose of radiation 100 times greater than expected.
  - Satellite failure.

STARFISH

- STARFISH longevity
  - Rate of decay
  - Studied in the late 1960s
  - In-depth study using data from the 1963-38C satellite performed in 1970-71.
    - Covered the time span from September 1963 to December 1968.

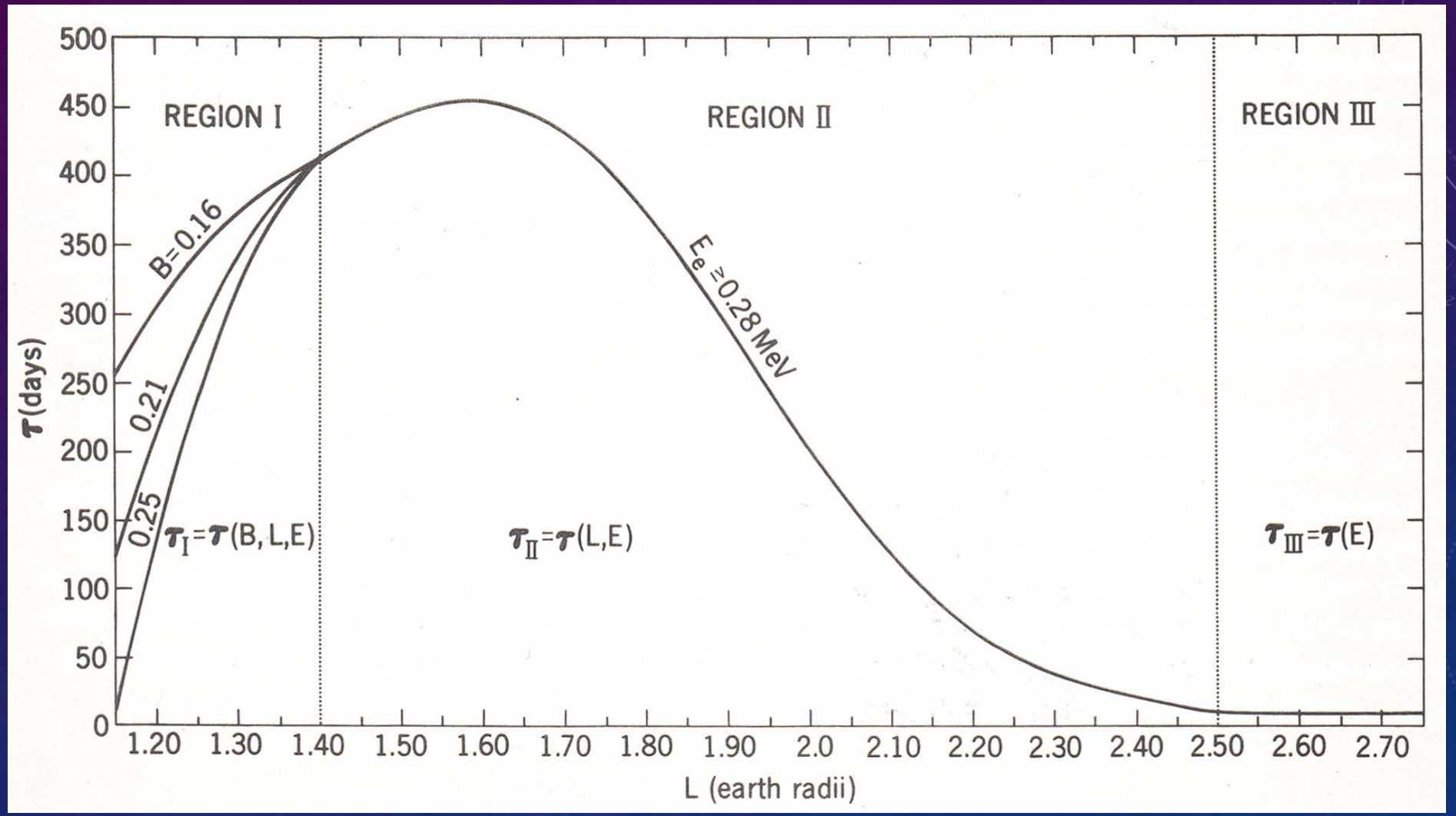
STARFISH

- In-depth study using data from the 1963-38C satellite performed in 1970-71.
  - Identified 3 distinct regions within the inner zone domain populated by the artificial electrons.
  - Established that their decay lifetime τ (in days) can be presented as a complex function of three variables.

STARFISH

- Magnetic Shell Parameter L (in Earth radii)
- Field Strength B (in Gauss)
- Energy E (in MeV)

STARFISH



Domains of functional dependence of the decay lifetime τ on B, L, and E for $E \geq 0.28$ MeV

STARFISH

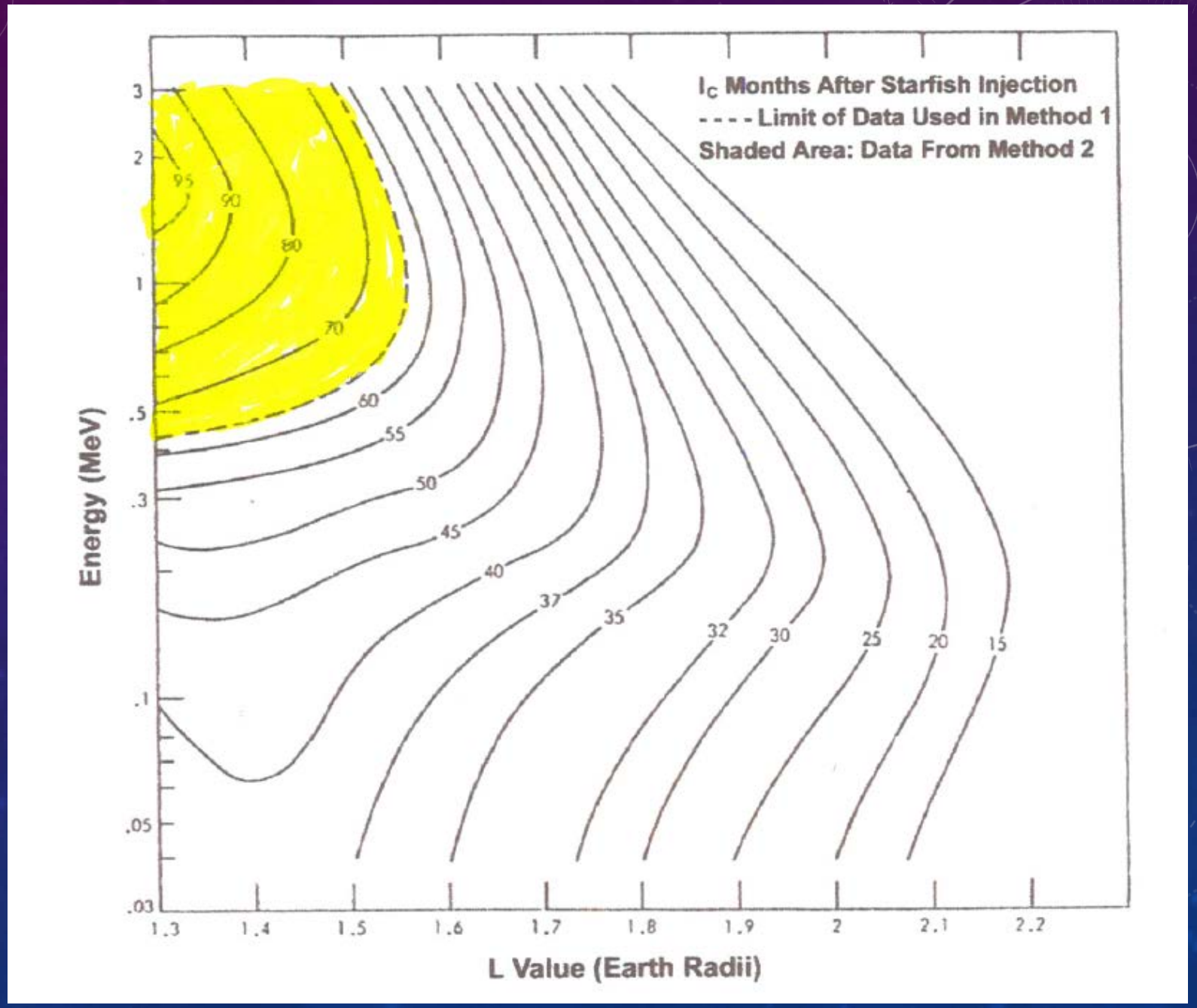
- A new analysis one year later produced a model of the STARFISH flux for September 1964.
- Based on data from the OGO-1, OGO-3, OGO-5, OV3-3, and 1963-38C spacecraft.

STARFISH

- Distinguished between artificial and natural electrons.
- Provided the artificial flux as a function of equatorial pitch angle, energy, and L value.
- Used two separate methods to determine decay times for this flux, combined to yield average values for the long-term loss process of the artificials.

STARFISH

- Threshold-energy vs. L-value map for decay cutoff times.



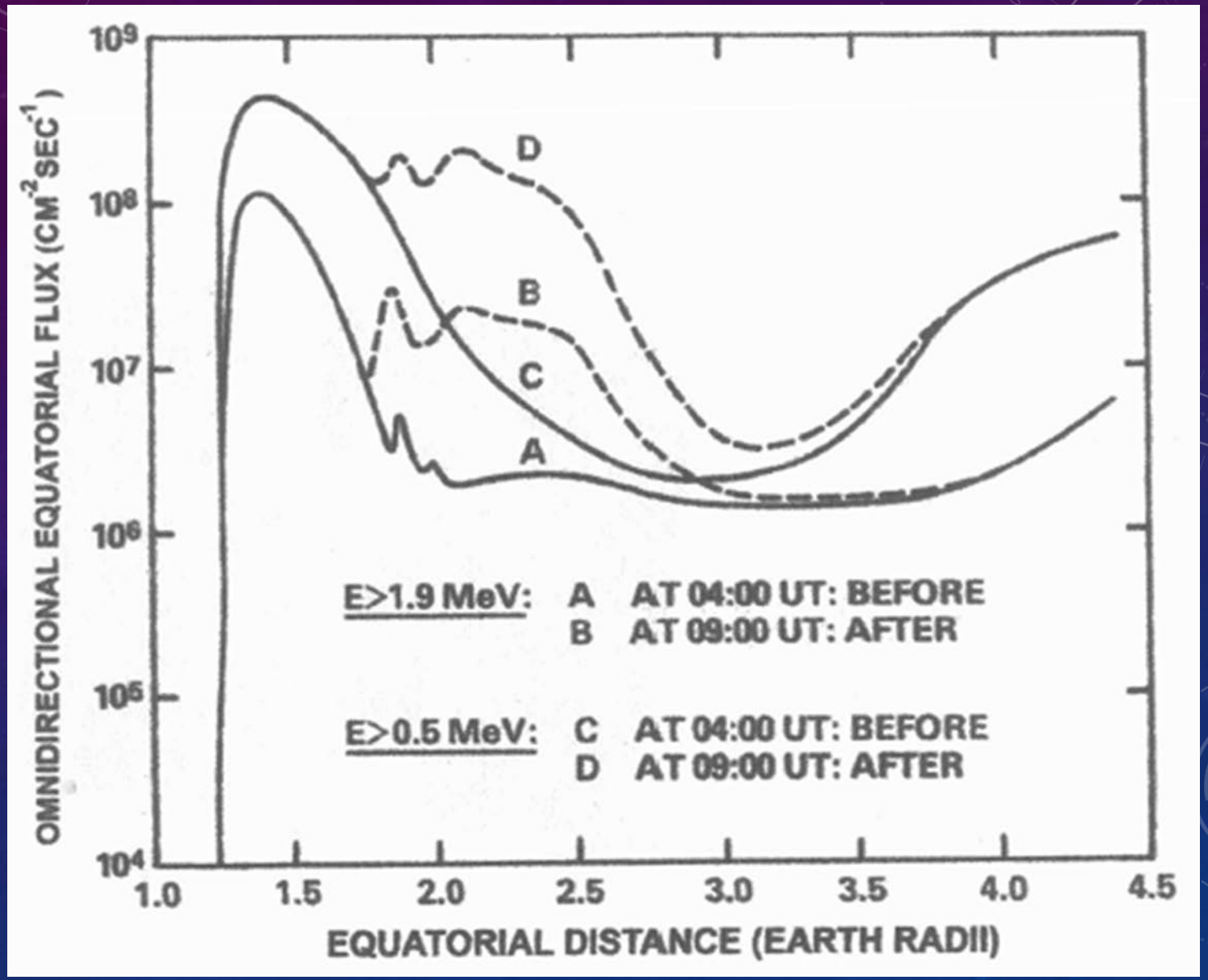
STARFISH

- Numerical values relating to nuclear explosions are not, and cannot be, exact.
  - Difficult to measure such events and their effects at the time of their occurrence.
  - Margin of error.
  - Occur under unpredictable circumstances.
  - Two nuclear weapons of different design may have the same explosive energy yield, but different effects.

STARFISH VS. SOVIETS

- Soviet high-altitude test of a low-yield weapon, October 28, 1962, Semipalatinsk, Kazakhstan.

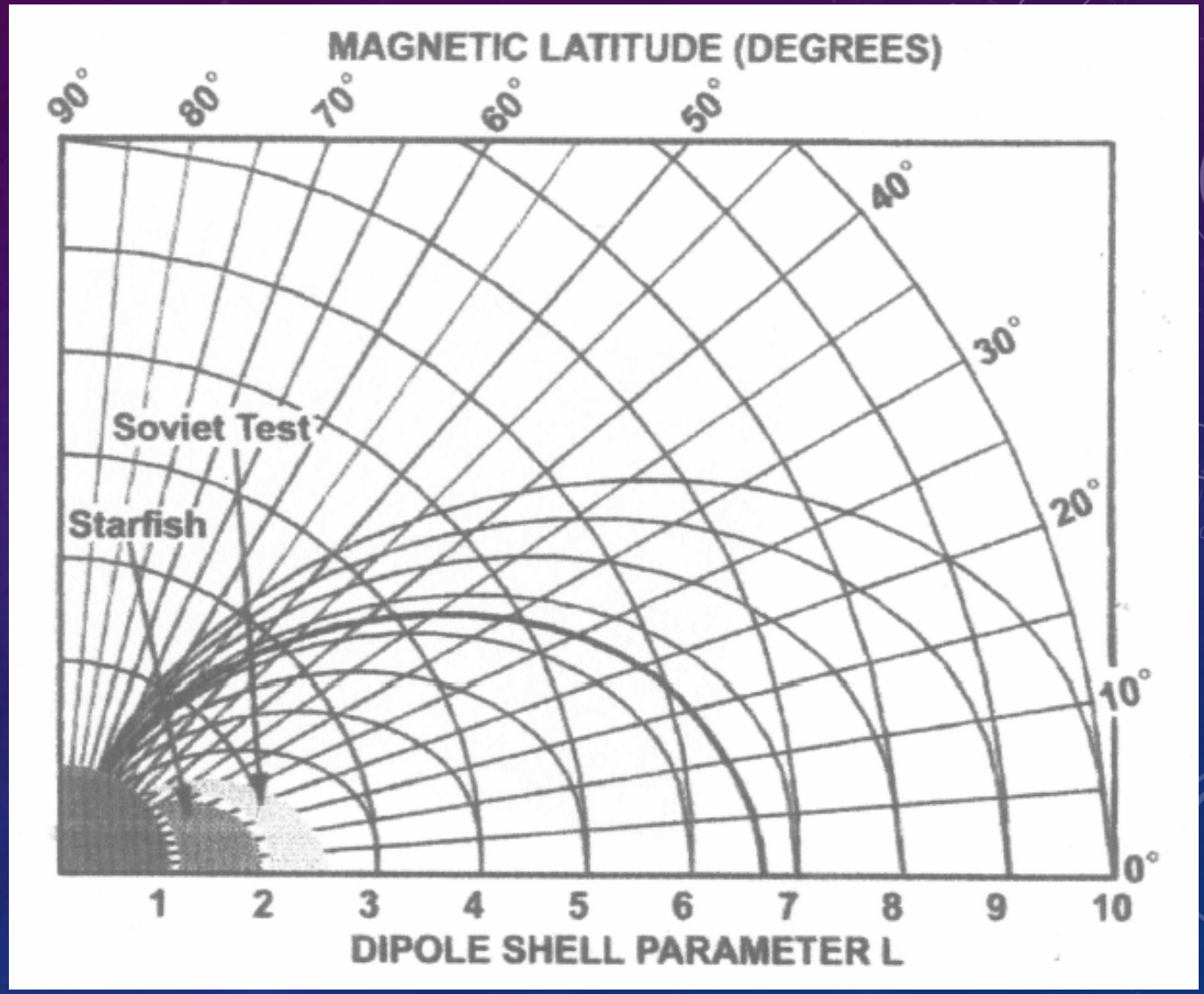
STARFISH VS. SOVIETS



Integral Van Allen belt electrons before and after the Soviet event

STARFISH VS. SOVIETS

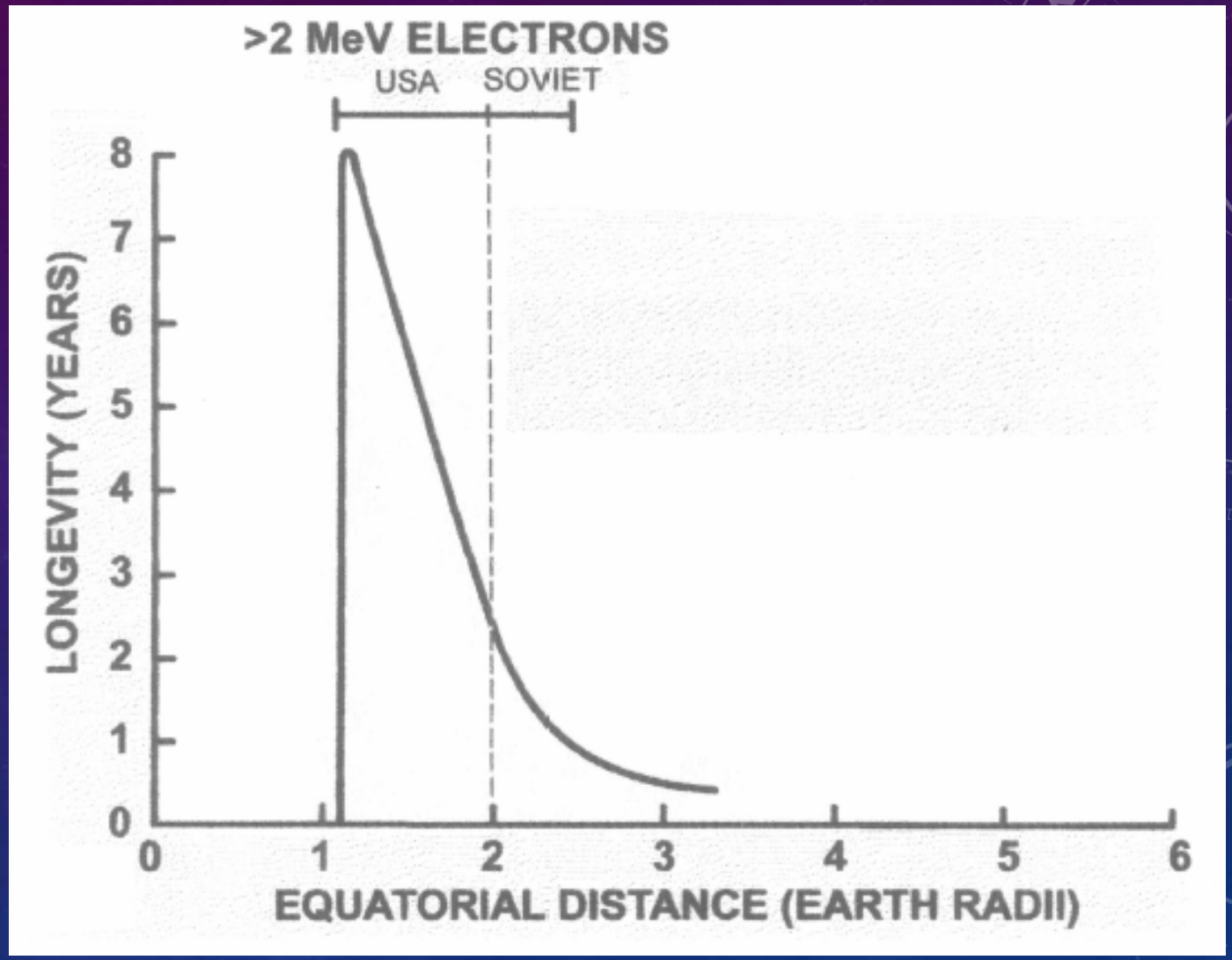
- Distribution of the fission electrons from these two tests in magnetic space.



Schematic of the distribution of fission electrons from the STARFISH and Soviet tests in magnetic coordinates

STARFISH VS. SOVIETS

- Average apparent lifetimes of the E>2 MeV electrons from the STARFISH and Soviet experiments.



Comparison of the average lifetimes of >2 MeV electrons for the STARFISH and Soviet tests

CONCLUSIONS

- Difficult to draw final conclusions from only two isolated tests.
- The data suggest that
  - Longevity is maximum at low L values (years)
  - Decreases rapidly towards the slot region
  - Settles into weeks and months thereafter

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